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## SOME OBSERVATIONS ON THE BLOOD OF DAIRY COWS IN TICK-INFESTED REGIONS.\*

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The material contained in this paper has been selected from a mass of data collected during the past two years. The subject was suggested by some observations made while conducting one of our Adams Fund projects. Our first set of results, obtained from a limited number of animals (15), when compared with the results of other observers in the hematological studies of the blood of normal cattle, brought to light some differences which could not then be explained. In view of this fact we thought it necessary to make a more thorough study in an attempt to account for these differences. In all over 50 individual animals have been examined, a few of which were subjected to repeated examination at various times of the year. Our observations during this period of time have not brought any change in the general result. We do not consider, however, that we have established a new normal, but according to data recently obtained we believe that what differences do exist between our data and those of other observers are entirely due to the influence of the Texas fever parasite upon the blood of the animals which have recovered from the disease. It is generally considered that the blood of cows that have had tick fever never attains the optimum condition that it maintained preceding an attack. To our knowledge nothing has been published in regard to the condition of the blood after recovery from Texas fever nor has anything appeared in the literature concerning the history of the leukocytes during or after an attack. It has, therefore, seemed advisable to publish our results.

### TECHNIC.

The blood was procured from a gash made by a spring fleam. This gash was made on the rump at a place most accessible to the operator and at the same time in a region where the blood could be made to ooze out with readiness. When the hair is clipped

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and the site thoroughly cleaned a good specimen of blood can be obtained. With proper care a clean sample of blood can be taken from between the lips of the gash. The counts are materially affected when dirt particles, oil droplets, and debris are taken up in the pipette. Every instrument and piece of apparatus was placed in readiness so that the work could be done quickly. After the operation the wound was treated with five per cent carbolic acid and the lips held together for a few seconds. This precaution was finally given up as unnecessary since no septic conditions were produced and the scars soon disappeared.

The samples of blood were taken during milking time, between four and five o'clock in the afternoon, while the cows were in the stalls, feeding. A few animals were nervous, but the majority took little or no notice of the slight operation. The ages of the animals varied from one to 12 years. After the samples had been gathered they were taken to the laboratory and counts made. During the winter it was too dark to do this work at once, so they were held over until the following morning. There appears to be little or no difference between the morning and evening results, or, in other words, between results obtained one hour or 14 hours after the samples are taken. What differences do show up are within the limit of error. The accompanying table is inserted to show this fact.

Two samples from each animal in the dilution of 1:200 were taken. One was examined on return to the laboratory while the other was put away for examination in the morning. (P.M.= samples taken in the afternoon and counts made within one hour after samples were collected. A.M.=samples taken in the afternoon but held until the morning following and then examined.)

TABLE 1.

| NUMBER       | P.M.      |        | A.M.      |        |
|--------------|-----------|--------|-----------|--------|
|              | Reds      | Whites | Reds      | Whites |
| 1.....       | 5,880,000 | 12,000 | 4,584,000 | 13,554 |
| 2.....       | 5,120,000 | 15,554 | 5,240,000 | 8,888  |
| 3.....       | 4,142,000 | 7,332  | 4,936,000 | 11,776 |
| 4.....       | 4,608,000 | 6,000  | 5,440,000 | 7,332  |
| Average..... | 4,940,000 | 10,221 | 5,050,000 | 10,387 |

The above method would afford a slight chance for error. The samples were taken by two individuals. Those to be examined immediately, by one, and those for morning study, by the other. We next took samples in the afternoon and held them over until the morning following, when they were counted together with samples taken in the morning. The evening and morning samples were taken from the same individual animals. (P.M.=samples taken in the afternoon and counted in the morning. A.M.=samples taken in the morning and counted within an hour after taking. In this case the samples were all taken by one individual.)

TABLE 2.

| NUMBER       | P.M.      |        | A.M.      |        |
|--------------|-----------|--------|-----------|--------|
|              | Reds      | Whites | Reds      | Whites |
| 382.....     | 5,744,000 | 11,110 | 7,504,000 | 8,888  |
| 383.....     | 5,080,000 | 13,776 | 5,544,000 | 16,888 |
| 384.....     | 7,152,000 | 9,822  | 6,352,000 | 12,000 |
| 385.....     | 6,680,000 | 12,000 | 6,752,000 | 10,222 |
| 393.....     | 5,792,000 | 8,000  | 6,336,000 | 10,666 |
| 397.....     | 5,624,000 | 14,776 | 6,344,000 | 20,222 |
| 399.....     | broken    | broken | 6,600,000 | 12,444 |
| 400.....     | 6,488,000 | 5,332  | 6,664,000 | 14,776 |
| Average..... | 6,080,000 | 10,688 | 6,512,000 | 13,263 |

The morning and evening counts are known to vary slightly.

Finally we took samples in the afternoon and within an hour from the time they were taken we began counting. After counting, the pipettes, which were about half full, were put aside and in the morning were counted again with the following results.

In this case all the samples were taken by one individual, and the morning and evening counts from the same pipette.

TABLE 3.  
FROM SAME PIPETTE.

| NUMBER       | P.M.      |        | A.M.      |        |
|--------------|-----------|--------|-----------|--------|
|              | Reds      | Whites | Reds      | Whites |
| 1.....       | 4,152,000 | 7,332  | 4,464,000 | 7,110  |
| 2.....       | 6,488,000 | 8,332  | 6,160,000 | 8,000  |
| 3.....       | 4,848,000 | 11,110 | 4,800,000 | 12,888 |
| 4.....       | 4,912,000 | 9,110  | 5,360,000 | 10,332 |
| 5.....       | 4,768,000 | 10,000 | 4,800,000 | 7,354  |
| 6.....       | 6,488,000 | 8,332  | 4,976,000 | 6,888  |
| 7.....       | 4,936,000 | 12,000 | 4,768,000 | 10,666 |
| Average..... | 5,227,000 | 9,460  | 5,047,000 | 9,062  |

We consider the above differences as within the limit of error.

The number of erythrocytes and leukocytes per c.c. was determined. Both sets of corpuscles were counted from the same preparation. The blood was diluted 1:200 with Toisson's fluid.

In this work the reds and whites were counted in the same preparation. To facilitate the work the dilution of 1:200 was used instead of the 1:100 dilution, as the number of red corpuscles to a square was large and rendered the counts tedious when so many examinations were made. We have found that the differences are small and fall within the limit of error. This may be observed in Table 4.

TABLE 4.

| NAME                 | DILUTION 1:100                 | DILUTION 1:200                 |
|----------------------|--------------------------------|--------------------------------|
|                      | No. of Leukocytes<br>per c.mm. | No. of Leukocytes<br>per c.mm. |
| Estelle.....         | 11,777                         | .....                          |
| Sweet Eyes.....      | 11,555                         | 13,776                         |
| 224.....             | 10,055                         | 9,554                          |
| Maimie.....          | 12,500                         | 10,666                         |
| 228.....             | 12,111                         | 13,844                         |
| Roxie.....           | 11,611                         | 12,444                         |
| Marjorie R.....      | 15,518                         | 17,110                         |
| Lucy R.....          | 7,296                          | 8,444                          |
| Lady Doth.....       | 9,950                          | 12,222                         |
| 316.....             | 14,444                         | bad                            |
| Cecile S.....        | 10,200                         | 8,666                          |
| 125.....             | 16,444                         | 16,000                         |
| Wayne P.....         | 8,000                          | 8,222                          |
| 116.....             | 10,332                         | 9,222                          |
| 100.....             | 15,777                         | 16,666                         |
| Lura K.....          | 15,888                         | 15,332                         |
| Timola's Lassie..... | 7,777                          | 8,444                          |
| Average.....         | 11,837                         | 12,040                         |

The Thomas Zeiss hematocytometer with the Zappert Ewing ruling was used for counting both reds and whites. In estimating the number of red cells, one hundred squares were counted. This operation was repeated with another drop, and if the results varied more than 25 from that obtained with the first drop, a third preparation was made and the three results averaged. In counting the white cells the number in the whole ruled area or nine squares was counted. Two preparations were examined as described above in the counting of the red cells. Whenever necessary a third preparation was made and an average taken of all three. A differential count of the leukocytes was also made. Wright's modification of Jenner's stain was used exclusively.

The hemoglobin was determined by use of Dare's hemoglobi-nometer. In some cases the results were checked by another person. The results were in fairly close agreement. Results obtained in different months and different years tallied quite closely.

The following tables have been taken from Dr. Burnett's book on *Clinical Examination of the Blood of Animals*.

| Red Corpuscles per c.mm. | Leukocytes per c.mm. | Hemoglobin per c.mm. | Specific Gravity | Size of Red Corpuscles | Authors             |
|--------------------------|----------------------|----------------------|------------------|------------------------|---------------------|
| 6,275,000                | .....                | ....                 | ....             | 4.6-7.2 m              | Bethe               |
| 6,152,000                | 5,486                | 59.7                 | ....             | .....                  | Dimock and Thompson |
| .....                    | .....                | ....                 | ....             | 5.95 m                 | Gulliver            |
| 4,200,000                | .....                | ....                 | ....             | 6 m                    | Malassez            |
| 6,000,000                | 9,730                | ....                 | ....             | 5-6 m                  | Smith and Kilbourne |
| 5,073,000                | .....                | ....                 | ....             | .....                  | Stoltzing           |
| 6,503,000*               | 7,841                | ....                 | ....             | .....                  | Storch              |
| 6,683,000†               | 9,367                | ....                 | ....             | .....                  | Storch              |
| 5,473,000‡               | 8,241                | ....                 | ....             | .....                  | Storch              |
| 7,055,000‡‡              | 11,614               | ....                 | ....             | .....                  | Storch              |
| 8,523,000§               | 15,739               | ....                 | ....             | .....                  | Storch              |

\* Bulls. † Oxen. ‡ Cows. ‡‡ Young cattle. § Calves.

Dimock and Thompson obtained the following numbers and percentages of the several varieties of leukocytes in the blood of normal cattle:

|                         | Per c.mm. | Average per cent | Minimum per cent | Maximum per cent |
|-------------------------|-----------|------------------|------------------|------------------|
| Lymphocytes.....        | 2,992     | 54.2             | 31               | 76               |
| Large mononuclears..... | 86        | 1.4              | 0.2              | 3.3              |
| Polymorphs.....         | 1,786     | 30.5             | 13.0             | 45.8             |
| Eosins.....             | 772       | 13.15            | 3.8              | 26.5             |
| Mast cells.....         | 31        | 0.59             | 0.1              | 1.2              |

Refik-Bey gives the normal number of leukocytes for cattle as 7,000-11,000 per c.mm., the number of mononuclears, including lymphocytes, as 4,500-6,500 per c.mm. (57-84 per cent), the number of polynuclears as 1,500-3,500 per c.mm.

The above is a summary of our present knowledge of the clinical work on the blood of cattle and is inserted here for purposes of comparison.

In our original work 15 animals were selected and placed in a feeding experiment. A clinical study of the blood was begun on October 22, 1908, and at first consisted in a count of erythrocytes only. The animals were heifers with their first calves. There were three lots of three each, making nine in all. Two months

TABLE 5.  
All animals are females and grade Jerseys. The number of red corpuscles is given as million per cubic centimeter. The number of white corpuscles is given as thousand per cubic centimeter.

| Number      | Age in Years | Time Taken       | Reds  | Whites | Average Reds | Average Whites | Number   | Age in Years | Time Taken | Reds  | Whites  | Average Reds | Average Whites |
|-------------|--------------|------------------|-------|--------|--------------|----------------|----------|--------------|------------|-------|---------|--------------|----------------|
| 382.....    | 3½           | 10-28-08         | 7.516 | 14.0   | .....        | .....          | 393..... | 3½           | 11-2-08    | 5.520 | 14.22   | .....        | .....          |
|             |              | 11-7-08          | 7.296 | 11.4   | .....        | .....          |          |              | 11-11-08   | 5.656 | 14.44   | .....        | .....          |
|             |              | 11-9-08          | 7.300 | 10.2   | .....        | .....          |          |              | 11-18-08   | 7.160 | 14.00   | .....        | .....          |
|             |              | 11-16-08         | 7.536 | 13.2   | .....        | .....          |          |              | 12-8-08    | 5.752 | 12.44   | .....        | .....          |
| 383.....    | 3½           | 2-8-09           | 7.696 | 10.2   | 7.480        | 11.8           | 397..... | 3            | 1-12-09    | 4.560 | 15.20   | .....        | .....          |
|             |              |                  |       |        |              |                |          |              | 2-9-09     | 6.248 | 13.11   | 5.816        | 13.9           |
|             |              | 11-4-08          | 7.680 | 24.0   | .....        | .....          |          |              | 10-22-08   | 7.472 | .....   | .....        | .....          |
|             |              | 11-18-08         | 5.280 | 18.8   | .....        | .....          |          |              | 11-7-08    | 3.397 | 10.0    | .....        | .....          |
| 384.....    | 3½           | 12-8-08          | 6.752 | 30.4   | .....        | .....          | 398..... | 3            | 11-9-08    | 5.384 | 14.0    | .....        | .....          |
|             |              | 1-12-09          | 6.640 | 28.8   | .....        | .....          |          |              | 11-16-08   | 6.312 | 11.0    | .....        | .....          |
|             |              | 2-9-09           | 5.400 | 14.3   | 6.350        | 23.3           |          |              | 12-7-08    | 4.688 | 4.66    | .....        | .....          |
|             |              |                  |       |        |              |                |          |              | 1-14-09    | 6.480 | 15.4    | .....        | .....          |
| 385.....    | 3½           | 10-29-08         | 7.697 | 14.0   | .....        | .....          | 399..... | 2½           | 2-8-09     | 6.080 | 11.7    | .....        | .....          |
|             |              | 11-10-08         | 6.800 | 7.4    | .....        | .....          |          |              | 3-9-09     | 5.480 | 17.5    | .....        | .....          |
|             |              | 11-17-08         | 7.296 | 9.4    | .....        | .....          |          |              | 4-6-09     | 6.744 | 14.0    | 5.782        | 12.29          |
|             |              | 11-23-08         | 7.600 | 8.0    | .....        | .....          |          |              | 10-20-08   | 7.440 | 16.22   | .....        | .....          |
| 386.....    | 3½           | 1-13-08          | 7.160 | 14.0   | 7.310        | 10.6           | 400..... | 2½           | 11-10-08   | 5.888 | 11.60   | .....        | .....          |
|             |              |                  |       |        |              |                |          |              | 11-17-08   | 7.256 | 12.00   | .....        | .....          |
|             |              | 10-29-08         | 5.960 | .....  | .....        | .....          |          |              | 11-23-08   | 7.280 | 15.20   | .....        | .....          |
|             |              | 11-10-08         | 5.936 | 9.4    | .....        | .....          |          |              | 2-10-09    | 7.216 | 11.76   | .....        | .....          |
| 387.....    | 3½           | 11-17-08         | 7.040 | 11.8   | .....        | .....          | 401..... | 2½           | 3-10-09    | 6.044 | 4.66    | .....        | .....          |
|             |              | 11-23-08         | 6.560 | 8.4    | .....        | .....          |          |              | 4-8-09     | 7.004 | 19.55   | 7.132        | 13.00          |
|             |              | 12-9-08          | 6.288 | 8.4    | .....        | .....          |          |              | 10-22-08   | 7.256 | 12.88   | .....        | .....          |
|             |              | 1-13-09          | 6.920 | 13.0   | .....        | .....          |          |              | 11-7-08    | 6.312 | 20.80   | .....        | .....          |
| 388.....    | 2½           | 2-10-09          | 7.160 | 9.3    | 6.552        | 10.0           | 402..... | 2½           | 11-16-08   | 7.200 | 8.88    | .....        | .....          |
|             |              |                  |       |        |              |                |          |              | 12-7-08    | 7.376 | 16.20   | .....        | .....          |
|             |              | 11-2-08          | 6.320 | 20.00  | .....        | .....          |          |              | 1-14-09    | 7.104 | 14.80   | .....        | .....          |
|             |              | 11-11-08         | 7.136 | 12.80  | .....        | .....          |          |              | 2-8-09     | 6.944 | 15.77   | 7.025        | 14.47          |
| 389.....    | 2½           | 11-18-08         | 7.000 | 11.00  | .....        | .....          | 403..... | 2½           |            |       |         |              |                |
|             |              | 1-12-09          | 6.720 | 13.54  | .....        | .....          |          |              |            |       |         |              |                |
|             |              | 2-9-09           | 7.256 | 12.88  | 6.887        | 14.04          |          |              |            |       |         |              |                |
|             |              | General Average. |       |        |              |                |          |              |            |       |         |              |                |
| Number..... |              | 382              | 383   | 384    | 385          | 393            | 397      | 398          | 399        | 400   | Average |              |                |
| Reds.....   |              | 7.480            | 6.350 | 7.310  | 6.552        | 5.816          | 5.782    | 7.132        | 6.887      | 7.025 | 6.704   |              |                |
| Whites..... |              | 11.80            | 23.26 | 10.56  | 10.06        | 13.90          | 12.29    | 13.00        | 14.04      | 14.47 | 13.71   |              |                |

TABLE 6.

| NUMBER   | DATE     | REDS  | WHITES | PERCENTAGE<br>OF<br>HEMOGLOBIN | POLYNUCLEARS |                 | MONONUCLEARS |                 | LYMPHOCYTES |                 | MAST   |                 | EOSINOPHILES |                 |
|----------|----------|-------|--------|--------------------------------|--------------|-----------------|--------------|-----------------|-------------|-----------------|--------|-----------------|--------------|-----------------|
|          |          |       |        |                                | Number       | Percent-<br>age | Number       | Percent-<br>age | Number      | Percent-<br>age | Number | Percent-<br>age | Number       | Percent-<br>age |
| 382..... | 4-6-09   | 7.152 | 8.88   | 82                             | 329          | 3.7             | ...          | ...             | 8,178       | 92.1            | 80     | 0.9             | 275          | 3.1             |
|          | 8-5-09   | 7.280 | 8.44   | 76                             | 2,583        | 30.0            | 287          | 3.4             | 6,060       | 71.8            | 101    | 1.2             | 75           | 8.0             |
|          | 3-8-10   | 6.552 | 12.44  | 100                            | 1,593        | 12.8            | 722          | 5.8             | 9,034       | 72.6            | 75     | 0.6             | 1,020        | 8.2             |
|          | 5-4-10   | 7.224 | 12.00  | 94                             | 1,044        | 8.7             | 156          | 1.3             | 0,636       | 80.3            | 48     | 0.4             | 1,032        | 8.6             |
|          | 6-24-10  | 7.008 | 15.55  | 93                             | 2,255        | 14.5            | 684          | 4.4             | 10,669      | 68.6            | 75     | 0.5             | 1,773        | 11.4            |
| 383..... | 11-14-10 | 6.320 | 11.44  | 95                             | 2,060        | 18.0            | ...          | ...             | 8,537       | 74.6            | 23     | 0.2             | 824          | 7.4             |
|          | 3-4-11   | 6.736 | 11.27  | 91                             | 1,173        | 10.4            | 180          | 1.6             | 8,615       | 76.4            | ...    | ...             | 1,285        | 11.4            |
|          | 3-9-09   | 4.576 | 24.55  | 90                             | ...          | ...             | ...          | ...             | ...         | ...             | ...    | ...             | ...          | ...             |
|          | 4-7-09   | 5.280 | 22.66  | 74                             | 1,243        | 4.6             | 101          | 0.4             | 20,852      | 92.0            | ...    | ...             | 680          | 3.0             |
|          | 8-5-09   | 3.456 | 17.77  | 85                             | 1,635        | 9.2             | 604          | 3.4             | 14,114      | 79.4            | 213    | 1.2             | 1,067        | 6.0             |
| 384..... | 3-9-10   | 4.392 | 21.11  | ...                            | 1,393        | 6.6             | 211          | 7.0             | 18,155      | 86.0            | 42     | 0.2             | 253          | 12.0            |
|          | 3-27-10  | 4.808 | 18.88  | 81                             | 1,511        | 8.0             | 661          | 3.5             | 14,433      | 77.0            | 57     | 0.3             | 1,880        | 10.0            |
|          | 5-4-10   | 4.792 | 22.33  | 95                             | 715          | 3.2             | 625          | 2.8             | 10,775      | 80.0            | 179    | 0.8             | 938          | 4.2             |
|          | 6-24-10  | 5.480 | 22.88  | 80                             | 2,724        | 11.9            | 572          | 2.5             | 17,182      | 75.2            | 206    | 0.9             | 2,083        | 9.0             |
|          | 11-14-10 | 4.700 | 15.33  | 80                             | 1,411        | 9.2             | 889          | 5.8             | 12,082      | 78.8            | 77     | 0.5             | 843          | 5.5             |
| 385..... | 3-4-11   | 5.000 | 20.22  | 81                             | 1,011        | 5.0             | 283          | 1.4             | 17,957      | 88.8            | 162    | 0.8             | 809          | 4.0             |
|          | 3-10-09  | 7.288 | 14.00  | 85                             | 3,654        | 26.1            | 546          | 3.9             | 8,624       | 61.6            | ...    | ...             | 1,148        | 8.2             |
|          | 4-8-09   | 6.752 | 9.33   | 75                             | 1,281        | 14.8            | ...          | ...             | 7,540       | 80.8            | ...    | ...             | 448          | 4.8             |
|          | 8-8-09   | 5.784 | 6.55   | 78                             | 1,311        | 20.0            | 210          | 3.2             | 4,483       | 68.4            | 26     | 0.4             | 472          | 7.2             |
|          | 3-10-10  | 5.520 | 9.76   | 80                             | 1,152        | 11.8            | 254          | 2.6             | 7,422       | 76.0            | 39     | 0.4             | 360          | 8.9             |
| 386..... | 5-6-10   | 5.184 | 8.00   | ...                            | 1,068        | 24.6            | 96           | 1.2             | 5,120       | 64.0            | 112    | 1.4             | 672          | 8.4             |
|          | 6-24-10  | 5.584 | 11.54  | 85                             | 1,455        | 12.6            | 185          | 1.6             | 8,877       | 76.00           | 115    | 1.0             | 366          | 7.5             |
|          | 3-4-11   | 6.112 | 9.11   | 83                             | 2,496        | 27.4            | 264          | 2.9             | 5,439       | 59.7            | 82     | 0.9             | 829          | 9.1             |
|          | 3-10-09  | 5.408 | 10.66  | 77                             | 1,422        | 13.4            | 491          | 4.6             | 7,909       | 75.0            | ...    | ...             | 747          | 7.0             |
|          | 8-4-09   | 5.816 | 10.22  | 72                             | 675          | 6.6             | ...          | ...             | 7,932       | 77.6            | 31     | 0.3             | 1,533        | 15.0            |
| 387..... | 3-10-10  | 6.000 | 12.11  | 80                             | ...          | ...             | ...          | ...             | ...         | ...             | ...    | ...             | ...          | ...             |
|          | 5-6-10   | 5.856 | 11.55  | 89                             | 2,623        | 22.7            | 716          | 6.2             | 7,152       | 61.9            | 173    | 1.5             | 1,040        | 9.0             |
|          | 6-24-10  | 5.632 | 16.66  | 95                             | 1,152        | 11.4            | 131          | 1.3             | 7,582       | 75.5            | 71     | 0.7             | 1,452        | 11.4            |
|          | 11-14-10 | 5.680 | 11.44  | 88                             | 1,067        | 10.0            | 140          | 1.4             | 8,063       | 75.6            | 32     | 0.3             | 1,337        | 12.5            |
|          | 3-4-11   | 5.048 | 12.66  | 88                             | 2,380        | 20.8            | 343          | 3.0             | 7,597       | 63.6            | 38     | 0.6             | 1,433        | 10.6            |
| 388..... | 3-4-11   | 5.048 | 12.66  | 88                             | 836          | 6.6             | 215          | 1.7             | 10,842      | 85.6            | ...    | ...             | 785          | 6.2             |

|          |          |       |       |     |       |      |      |      |        |      |     |     |       |      |
|----------|----------|-------|-------|-----|-------|------|------|------|--------|------|-----|-----|-------|------|
| 393..... | 3-10-00  | 6.176 | 14.22 | 87  | 113   | 8.0  | 455  | 3.2  | 11,605 | 81.6 | ... | ... | 1.024 | 7.2  |
|          | 8-7-00   | 4.336 | 10.66 | 83  | ...   | ...  | ...  | ...  | ...    | ...  | ... | ... | ...   | ...  |
|          | 3-4-00   | 5.760 | 15.55 | 85  | 1,403 | 9.6  | 321  | 2.0  | 12,505 | 80.4 | 120 | 0.8 | 1,064 | 6.2  |
|          | 0-24-10  | 5.376 | 14.22 | 84  | 1,010 | 7.1  | ...  | 1.58 | 13,088 | 81.8 | 90  | 0.6 | 1,184 | 7.4  |
|          | 11-14-10 | 5.840 | 16.00 | 84  | 1,378 | 8.0  | 280  | 2.5  | 11,354 | 81.1 | 190 | 1.4 | 788   | 5.2  |
| 397..... | 3-4-11   | 5.784 | 8.00  | 80  | 1,408 | 8.8  | 80   | 0.5  | 14,432 | 88.2 | ... | ... | 368   | 2.3  |
|          | 8-4-09   | 3.792 | 14.22 | 73  | 290   | 3.7  | 80   | 1.0  | 7,280  | 91.0 | ... | ... | 320   | 4.0  |
|          | 3-9-10   | 4.960 | 20.22 | 90  | 1,749 | 12.3 | 497  | 3.5  | 10,766 | 75.7 | 71  | 0.5 | 1,093 | 7.7  |
|          | 5-4-10   | 4.816 | 20.00 | 87  | 2,184 | 10.8 | 749  | 3.7  | 10,393 | 86.8 | 202 | ... | 708   | 3.8  |
|          | 0-24-10  | 5.740 | 27.06 | 90  | 1,160 | 5.8  | 348  | 0.6  | 17,280 | 86.4 | ... | ... | 1,440 | 7.2  |
| 398..... | 3-4-11   | 6.496 | 17.77 | 88  | 2,084 | 10.8 | 442  | 1.6  | 23,850 | 86.2 | ... | ... | 387   | 1.4  |
|          | 8-4-09   | 7.192 | 16.44 | 86  | 1,955 | 11.0 | 356  | 2.0  | 14,252 | 86.8 | 71  | 0.4 | 1,013 | 5.7  |
|          | 3-11-10  | 6.712 | 8.22  | 80  | 1,809 | 11.0 | 99   | 0.6  | 13,320 | 81.0 | 33  | 0.2 | 200   | 7.3  |
|          | 0-24-10  | 7.720 | 17.77 | 98  | 1,685 | 13.2 | 126  | 2.5  | 6,520  | 79.3 | 90  | 1.1 | 271   | 3.3  |
|          | 3-4-11   | 7.450 | 9.55  | 98  | 2,600 | 11.8 | 284  | 1.6  | 14,207 | 81.5 | 107 | 4.6 | 782   | 4.4  |
| 399..... | 3-9-09   | 7.080 | 18.66 | 85  | 1,127 | 11.8 | 210  | 2.2  | 8,635  | 84.1 | ... | ... | 102   | 1.7  |
|          | 8-8-00   | 6.296 | 12.00 | 80  | 4,666 | 25.0 | 1903 | 10.2 | 9,333  | 50.0 | 93  | 5.0 | 2,650 | 14.2 |
|          | 3-9-10   | 6.360 | 9.55  | 93  | 1,806 | 14.3 | 181  | ...  | ...    | ...  | ... | ... | ...   | ...  |
|          | 3-4-10   | 6.016 | 13.77 | 100 | 1,840 | 6.1  | 344  | 1.9  | 7,127  | 74.6 | 47  | 0.5 | 882   | 8.4  |
|          | 3-4-10   | 5.992 | 14.00 | 97  | 1,792 | 12.8 | ...  | 2.5  | 11,704 | 85.4 | ... | ... | 885   | 5.7  |
| 400..... | 3-4-11   | 5.728 | 19.11 | 93  | 1,101 | ...  | ...  | ...  | 10,416 | 74.4 | 14  | 1.0 | 1,820 | 13.0 |
|          | 3-9-09   | 6.624 | 10.55 | 98  | ...   | 11.1 | 116  | 1.1  | 8,791  | 83.3 | 31  | 0.3 | ...   | ...  |
|          | 8-8-00   | 7.400 | 24.22 | 90  | 1,598 | 6.6  | 218  | 0.9  | 18,917 | 98.1 | 454 | 2.7 | 2,858 | 11.8 |
|          | 3-9-09   | 6.560 | 17.55 | 88  | 2,837 | ...  | ...  | ...  | ...    | ...  | ... | ... | ...   | ...  |
|          | 3-28-10  | 5.928 | 11.44 | 85  | 1,559 | 15.2 | 93   | 5.0  | 12,730 | 68.2 | 75  | 0.4 | 2,016 | 10.8 |
| 400..... | 3-4-10   | 3.776 | 14.08 | 87  | 1,476 | 8.4  | 280  | 4.0  | 8,438  | 74.0 | 40  | 0.4 | 915   | 8.0  |
|          | 0-24-10  | 6.992 | 10.88 | ... | 1,216 | 7.2  | 253  | 2.0  | 11,488 | 79.2 | 80  | 0.4 | 1,430 | 10.4 |
|          | 3-4-11   | 5.912 | 10.44 | 87  | 3,075 | 18.7 | 608  | 1.5  | 12,809 | 70.2 | 180 | 1.1 | 1,430 | 13.7 |
|          |          |       |       |     |       |      |      | 3.7  | 9,702  | 59.0 | ... | ... | 3,042 | 18.5 |

later six yearling heifers were introduced into the experiment. This completed the total number of animals to be examined. Table 5 gives the results for each individual for five or six different examinations extending over a period of four months. A differential count was also made and will be found in Table 7.

Table 6 includes further observations on the same animals and, in addition, shows the percentages of hemoglobin, and the number and percentage of the five different varieties of leukocytes. The observations over a period extending from March, 1909, to March, 1911.

In the following tables we have the observations made on the six calves introduced in the experiment two months after it was started. The period of experimentation extended from January 27, 1909 to March 11, 1911.





TABLE 8.  
GENERAL AVERAGES OF REDS, WHITES, DIFFERENTIAL COUNTS OF WHITES AND HEMOGLOBIN.

| NUMBER   | REDS  | WHITES | PERCENTAGE<br>OF<br>HEMOGLOBIN | POLYNUCLEARS |            | MONONUCLEARS |            | LYMPHOCYTES |            | MAST   |            | EOSINOPHILES |            |
|----------|-------|--------|--------------------------------|--------------|------------|--------------|------------|-------------|------------|--------|------------|--------------|------------|
|          |       |        |                                | Number       | Percentage | Number       | Percentage | Number      | Percentage | Number | Percentage | Number       | Percentage |
| 382..... | 6.806 | 11.43  | 90                             | 1,612        | 14.1       | 377          | 3.3        | 8,735       | 76.4       | 69     | 0.6        | 938          | 8.2        |
| 383..... | 4.720 | 20.64  | 83                             | 1,486        | 7.2        | 536          | 2.6        | 17,172      | 83.2       | 123    | 0.6        | 1,382        | 6.7        |
| 384..... | 6.032 | 9.75   | 81                             | 1,912        | 19.6       | 244          | 2.5        | 6,801       | 60.6       | 78     | 0.8        | 2,677        | 12.2       |
| 385..... | 5.708 | 11.92  | 81                             | 1,559        | 13.0       | 357          | 3.0        | 8,791       | 73.7       | 71     | 0.6        | 1,216        | 10.2       |
| 393..... | 5.360 | 12.33  | 85                             | 974          | 7.9        | 210          | 1.7        | 10,397      | 84.3       | 101    | 0.9        | 654          | 5.3        |
| 397..... | 5.180 | 10.07  | 85                             | 2,018        | 10.1       | 439          | 2.2        | 16,360      | 81.9       | 120    | 0.6        | 1,019        | 5.1        |
| 398..... | 7.270 | 12.90  | 90                             | 1,547        | 11.9       | 221          | 1.7        | 10,580      | 81.4       | 78     | 0.6        | 533          | 4.1        |
| 399..... | 6.419 | 13.95  | 92                             | 1,025        | 13.8       | 544          | 3.9        | 13,044      | 93.5       | 70     | 0.5        | 1,242        | 8.9        |
| 400..... | 6.164 | 17.03  | 86                             | 1,907        | 11.2       | 494          | 2.9        | 12,330      | 72.4       | 136    | 0.8        | 2,677        | 12.2       |

TABLE 9.

General average of six calves sampled between the dates of January 27, 1909, and March 11, 1911.

Reds. .... 6,742,000  
Whites. .... 11,632

DIFFERENTIAL COUNT OF LEUKOCYTES OF THE ABOVE SIX CALVES.

|                    | Per c.c. | Average<br>per cent | Minimum<br>per cent | Maximum<br>per cent |                       |
|--------------------|----------|---------------------|---------------------|---------------------|-----------------------|
| Lymphocytes. ....  | 9,740    | 77.8                | 49.8                | 95.0                | Personal observations |
| Mononuclears. .... | 452      | 3.8                 | 0.6                 | 21.6                |                       |
| Polynuclears. .... | 1,873    | 14.6                | 3.8                 | 30.9                |                       |
| Eosins. ....       | 524      | 3.9                 | 0.1                 | 10.5                |                       |
| Mast. ....         | 92       | 0.6                 | 0.1                 | 1.2                 |                       |

Before the work represented in the above tables was completed it was seen that the results in some respects were different from those obtained by other workers in this line. It seemed necessary, therefore, to determine if possible the cause of this difference, so a number of animals in the general herd living under supposedly normal conditions were tested. In Table 10 we have the results obtained from 41 individual cattle.

TABLE 10.

| NAME                     | BREED           | DATE    | AGE IN YEARS | REDS      | WHITES | PER-CENTAGE OF HEMOGLOBIN | POLYNUCLEARS |             | MONONUCLEARS |             | LYMPHOCYTES |             | MAST   |             | EOSINOPHILES |             |
|--------------------------|-----------------|---------|--------------|-----------|--------|---------------------------|--------------|-------------|--------------|-------------|-------------|-------------|--------|-------------|--------------|-------------|
|                          |                 |         |              |           |        |                           | Number       | Per-centage | Number       | Per-centage | Number      | Per-centage | Number | Per-centage | Number       | Per-centage |
| Boyd.....                | P. B. J.....    | 3-13-10 | 2            | 6,440,000 | 11,776 | 70                        | .....        | .....       | .....        | .....       | .....       | .....       | .....  | .....       | .....        | .....       |
| 86.....                  | G. J.....       | 3-31-10 | 3            | 5,568,000 | 14,444 | 90                        | .....        | .....       | .....        | .....       | .....       | .....       | .....  | .....       | .....        | .....       |
| Fair Tabby.....          | P. B. J.....    | 6-2-10  | 13           | .....     | .....  | .....                     | .....        | .....       | .....        | .....       | .....       | .....       | .....  | .....       | .....        | .....       |
| Bettie's Hef.....        | P. B. R. P..... | 6-15-09 | 6            | 7,816,000 | 26,222 | .....                     | 1,075        | 6.1         | .....        | 0.7         | 24,622      | 84.2        | .....  | .....       | 288          | 8.8         |
| 171.....                 | G. J.....       | 1-15-09 | 4            | 6,464,000 | 18,444 | 89                        | 983          | 7.0         | .....        | .....       | 10,615      | 93.0        | 184    | 0.7         | 313          | 1.1         |
| R. Sanders.....          | G. R. P.....    | 6-16-09 | 9            | 5,980,000 | 18,444 | 83                        | 738          | 4.0         | .....        | .....       | 10,117      | 76.3        | 235    | 0.2         | 340          | 4.2         |
| Meslova's Pet.....       | P. B. R. P..... | 6-16-09 | 6            | 5,464,000 | 11,554 | 88                        | 2,632        | 18.0        | .....        | .....       | 8,514       | 85.7        | 58     | 1.2         | 1,433        | 18.0        |
| Maud.....                | P. B. R. P..... | 6-16-09 | 7            | 6,704,000 | 10,222 | 88                        | 848          | 8.2         | .....        | .....       | 8,769       | 85.2        | 51     | 0.5         | 593          | 5.8         |
| 230.....                 | G. J.....       | 3-23-10 | 8            | 6,208,000 | 8,444  | 94                        | 1,266        | 15.0        | 228          | 2.7         | 6,519       | 77.2        | .....  | .....       | 355          | 4.2         |
| 92.....                  | G. J.....       | 3-23-10 | 3            | 5,200,000 | 10,833 | 81                        | 2,792        | 16.1        | 540          | 3.2         | 17,720      | 98.4        | 34     | 0.2         | 2,027        | 12.0        |
| 330.....                 | G. J.....       | 3-23-10 | 6            | 6,730,000 | 10,888 | 98                        | 1,753        | 16.1        | 217          | 2.0         | 8,493       | 87.0        | .....  | .....       | 403          | 3.7         |
| 203.....                 | G. J.....       | 3-23-10 | 2            | 5,832,000 | 12,220 | 95                        | 769          | 5.8         | 444          | 2.0         | 10,609      | 82.4        | 73     | 0.6         | 1,124        | 9.2         |
| 84.....                  | G. J.....       | 3-31-10 | 3            | 5,784,000 | 25,776 | 99                        | 5,032        | 19.6        | 851          | 3.3         | 17,889      | 90.4        | 103    | 0.4         | 3,248        | 12.6        |
| 364.....                 | P. B. R. P..... | 3-31-10 | 3            | 5,160,000 | 19,110 | 93                        | 2,216        | 11.6        | 573          | 3.0         | 14,523      | 76.0        | 191    | 1.0         | 1,529        | 8.0         |
| Turner.....              | G. J.....       | 6-15-09 | 3            | 5,880,000 | 14,444 | 87                        | 1,632        | 11.3        | .....        | .....       | 12,360      | 85.2        | .....  | .....       | 404          | 2.8         |
| Butts 85.....            | G. J.....       | 6-15-09 | 5            | 5,880,000 | 17,444 | 87                        | 544          | 3.4         | .....        | .....       | 14,360      | 91.1        | 192    | 1.2         | 576          | 3.6         |
| 91.....                  | G. J.....       | 6-15-09 | 3            | 6,600,000 | 27,110 | 97                        | 2,660        | 7.4         | .....        | .....       | 23,863      | 87.8        | 81     | 0.3         | 1,106        | 4.3         |
| 20.....                  | G. J.....       | 6-15-09 | 10           | 5,912,000 | 13,110 | 81                        | 2,910        | 22.2        | .....        | .....       | 8,535       | 65.1        | 249    | 1.9         | 1,390        | 10.6        |
| 39.....                  | G. J.....       | 6-15-09 | 8            | 5,362,000 | 4,388  | 81                        | 840          | 9.0         | .....        | .....       | 3,612       | 63.9        | 34     | 0.3         | 391          | 8.0         |
| 78.....                  | G. J.....       | 6-7-09  | 7            | 5,838,000 | 10,222 | 81                        | 2,910        | 7.3         | .....        | .....       | 9,077       | 80.1        | 34     | 0.3         | 1,213        | 10.7        |
| 111.....                 | G. J.....       | 6-7-09  | 7            | 6,888,000 | 13,110 | 80                        | 2,910        | 18.4        | .....        | .....       | 8,769       | 80.0        | 58     | 0.5         | 1,622        | 10.0        |
| 100.....                 | G. J.....       | 7-5-10  | 3            | 4,984,000 | 8,000  | 85                        | 832          | 10.4        | 208          | 2.6         | 10,386      | 74.2        | 98     | 0.7         | 882          | 6.3         |
| Evelene.....             | P. B. J.....    | 7-5-10  | 4            | 5,576,000 | 6,932  | 85                        | 612          | 9.4         | 206          | 3.1         | 6,590       | 86.0        | 32     | 0.4         | 624          | 7.8         |
| Lura K.....              | P. B. J.....    | 7-5-10  | 3            | 5,280,000 | 11,666 | 91                        | 1,248        | 13.7        | 455          | 3.9         | 8,400       | 72.0        | 40     | 0.6         | 491          | 7.4         |
| Timola's Lassie.....     | P. B. J.....    | 7-5-10  | 4            | 5,702,000 | 12,554 | 70                        | 1,720        | 13.7        | 635          | 4.9         | 9,452       | 73.7        | 23     | 0.2         | 900          | 8.4         |
| 225.....                 | G. J.....       | 6-2-10  | 6            | 5,600,000 | 9,544  | 65                        | 1,720        | 11.5        | 357          | 4.6         | 5,243       | 78.1        | .....  | .....       | 942          | 7.8         |
| 66.....                  | G. J.....       | 6-7-09  | 6            | 5,616,000 | 12,666 | 85                        | 1,716        | 11.7        | 190          | 1.5         | 7,818       | 78.1        | 29     | 0.3         | 521          | 8.2         |
| 272.....                 | G. J.....       | 6-7-09  | 7            | 6,056,000 | 7,776  | 84                        | 1,024        | 7.3         | .....        | .....       | 10,448      | 81.6        | .....  | .....       | 773          | 8.2         |
| 18.....                  | G. J.....       | 4-21-09 | 12           | 5,400,000 | 8,554  | 83                        | 544          | 28.0        | .....        | .....       | 5,943       | 77.6        | 69     | 0.9         | 1,105        | 9.2         |
| 103.....                 | G. J.....       | 4-21-09 | 8            | 6,976,000 | 8,000  | 81                        | 838          | 10.1        | .....        | .....       | 5,943       | 77.6        | 85     | 1.0         | 1,118        | 9.2         |
| 202.....                 | G. J.....       | 4-13-09 | 10           | 6,976,000 | 8,000  | 86                        | 1,248        | 13.6        | .....        | .....       | 3,518       | 65.0        | .....  | .....       | 788          | 8.4         |
| 118.....                 | G. J.....       | 4-12-09 | 2            | 5,320,000 | 11,110 | 78                        | 911          | 18.6        | 533          | 4.8         | 5,550       | 83.2        | 48     | 0.6         | 848          | 10.6        |
| 104.....                 | G. J.....       | 6-2-10  | 6            | 5,304,000 | 6,732  | 88                        | 1,248        | 13.6        | .....        | .....       | 9,443       | 83.2        | 44     | 0.4         | 377          | 3.4         |
| Estelle.....             | P. B. J.....    | 6-2-10  | 7            | 6,304,000 | 15,332 | 90                        | 1,894        | 10.4        | 288          | 2.4         | 12,909      | 80.0        | 94     | 1.4         | 673          | 10.0        |
| Bettie.....              | P. B. R. P..... | 7-10-10 | 8            | 5,376,000 | 8,222  | 98                        | 864          | 7.2         | 65           | 0.8         | 10,138      | 84.6        | .....  | .....       | 60           | 5.0         |
| 174.....                 | G. J.....       | 3-29-10 | 5            | 7,668,000 | 7,666  | 96                        | 2,000        | 27.0        | .....        | .....       | 5,688       | 70.4        | .....  | .....       | 353          | 4.2         |
| Roxie L.....             | P. B. J.....    | 6-2-10  | 5            | 5,592,000 | 11,998 | 89                        | 1,363        | 17.0        | 131          | 1.1         | 8,490       | 71.7        | .....  | .....       | 850          | 11.1        |
| Maimie L.....            | P. B. J.....    | 6-2-10  | 10           | 6,000,000 | 11,110 | 70                        | 955          | 8.5         | 133          | 1.2         | 8,099       | 78.3        | .....  | .....       | 1,403        | 11.7        |
| Average of 41 cases..... | .....           | .....   | 5.7          | 6,053,600 | 12,661 | 83                        | .....        | 11.7        | .....        | 2.5         | .....       | 77.9        | .....  | .....       | .....        | 7.8         |
| Average of 15 cases..... | .....           | .....   | ...          | 6,338,000 | 14,080 | 85                        | .....        | 12.0        | .....        | 2.0         | .....       | 79.0        | .....  | .....       | .....        | 7.6         |

NOTE.—P. B. J. = Pure Bred Jersey; G. J. = Grade Jersey; P. B. R. P. = Pure Bred Red Poll; G. R. P. = Grade Red Poll.

## COMPARISON OF RESULTS.

General average of nine cows sampled between the dates of October 22, 1908, and April 8, 1909. These were on a feeding experiment.

Reds. .... 6,704,000  
Whites. .... 13,712

General average of nine cows sampled between the dates of March 9, 1909, and March 4, 1911. These were on a feeding experiment.

Reds. .... 5,972,000  
Whites. .... 14,449  
Hemoglobin. .... 85 per cent

Average of the above results.

Reds. .... 6,338,000  
Whites. .... 14,080  
Hemoglobin. .... 85 per cent

Average of 41 cows in the general herd. These were not in any experiment.

Reds. .... 6,053,600  
Whites. .... 12,361  
Hemoglobin. .... 83.7 per cent

| Red Corpuscles<br>per c.c. | Leukocytes<br>per c.c. | Hemoglobin<br>per cent | Authors                             |
|----------------------------|------------------------|------------------------|-------------------------------------|
| 6,152,000                  | 5,486                  | 59.7                   | Dimock and Thompson                 |
| 6,000,000                  | 9,730                  | ....                   | Smith and Kilbourne                 |
| 5,473,000                  | 8,241                  | ....                   | Storch                              |
| 6,053,600                  | 12,361                 | 83.7                   | Personal observations<br>(41 cases) |

## DIFFERENTIAL COUNT OF LEUKOCYTES.

|                          | Per c.c. | Average<br>per cent | Minimum<br>per cent | Maximum<br>per cent |                     |
|--------------------------|----------|---------------------|---------------------|---------------------|---------------------|
| Lymphocytes. ....        | 2,992    | 54.2                | 31.0                | 76.0                | Dimock and Thompson |
| Large mononuclears. .... | 86       | 21.4                | 20.2                | 3.3                 |                     |
| Polymorphonuclears. .... | 1,786    | 30.5                | 13.0                | 45.8                |                     |
| Eosins. ....             | 772      | 13.15               | 3.8                 | 26.5                |                     |
| Mast. ....               | 31       | 0.59                | 0.1                 | 1.2                 |                     |

## RESULTS OF OBSERVATION ON 41 COWS IN GENERAL HERD.

|                          | Per c.c. | Average<br>per cent | Minimum<br>per cent | Maximum<br>per cent |                       |
|--------------------------|----------|---------------------|---------------------|---------------------|-----------------------|
| Lymphocytes. ....        | 9,568    | 79.9                | 65.0                | 93.9                | Personal observations |
| Large mononuclears. .... | 327      | 2.5                 | 0.7                 | 4.9                 |                       |
| Polymorphonuclears. .... | 1,820    | 11.7                | 3.4                 | 28.0                |                       |
| Eosins. ....             | 1,005    | 7.8                 | 1.1                 | 18.0                |                       |
| Mast. ....               | 80       | 0.7                 | 0.2                 | 1.9                 |                       |

RESULTS OF OBSERVATION ON NINE IN A FEEDING EXPERIMENT.

|                              | Per c.c. | Average<br>per cent | Minimum<br>per cent | Maximum<br>per cent |                       |
|------------------------------|----------|---------------------|---------------------|---------------------|-----------------------|
| Lymphocytes . . . . .        | 12,283   | 79.6                | 50.0                | 92.1                | Personal observations |
| Large mononuclears . . . . . | 368      | 2.6                 | 0.4                 | 10.2                |                       |
| Polymorphonuclears . . . . . | 1,620    | 12.0                | 3.2                 | 30.6                |                       |
| Eosins . . . . .             | 963      | 7.6                 | 1.4                 | 18.5                |                       |
| Mast . . . . .               | 98       | 0.7                 | 0.2                 | 2.7                 |                       |

A glance at the preceding tables will reveal some differences when compared with the already accepted data of other observers. At first the records were thought to be faulty though the methods used were the same then as now. The work was done then with as great care as at the present time. The work was repeated and allowed to extend over long periods. The results were, in general, the same as at first. No reason could be given to account for the differences. The idea, however, that the Texas fever parasite must exert some influence persistently suggested itself. In order to see if there was any foundation for this belief five yearling heifers which had just been imported from Pennsylvania were examined and a normal established. Afterward these same animals were inoculated with Texas fever organisms. One died within the prescribed 10 days and within 15 minutes of the time of death the blood was examined. The other animals all survived the treatment and after three later attacks the blood was sampled at intervals as shown in the table below. No definite conclusions should rightly be made, since the number of cases are few, but the indications strengthen the belief that the differences between our observations and those of other workers are traceable to the Texas fever protozoon.

The following tables include further observations on the same animals, and, in addition, show the percentage of hemoglobin and the number and percentage of the five different varieties of leukocytes.

The results of the tables can be more strikingly arranged in the following manner: The animals had recovered from three attacks and had been passed on as in good condition a month before the clinical examination represented in the second column. The

TABLE II.  
Normal (before Treatment with Texas Fever Organisms).

| NAME OF ANIMAL   | DATE     | REDS      | WHITES | PER-<br>CENTAGE<br>OF HEMO-<br>GLOBIN | POLYNUCLEARS |                 | MONONUCLEARS |                 | LYMPHOCYTES |                 | MAST   |                 | EOSINOPHILES |                 |
|--|----------|-----------|--------|---------------------------------------|--------------|-----------------|--------------|-----------------|-------------|-----------------|--------|-----------------|--------------|-----------------|
|  |          |           |        |                                       | Number       | Percent-<br>age | Number       | Percent-<br>age | Number      | Percent-<br>age | Number | Percent-<br>age | Number       | Percent-<br>age |
| Daisy . . . . .  | 7-13-10  | 7,424,000 | 9,440  | 98                                    | 1,133        | 12.0            | 283          | 3.0             | 7,770       | 82.4            | 38     | 0.4             | 264          | 2.8             |
| Megs of Hyland . . . . .   | 7-13-10  | 6,992,000 | 10,666 | 96                                    | 1,920        | 18.0            | 107          | 1.0             | 8,127       | 76.2            | ..     | ..              | 405          | 3.8             |
| Yearling . . . . .   | 7-13-10  | 7,656,000 | 6,222  | 95                                    | 759          | 12.2            | 759          | 1.2             | 8,251       | 84.4            | 37     | 0.6             | 160          | 1.6             |
| Lady Monkland . . . . .  | 7-13-10  | 5,268,000 | 10,666 | 100                                   | 2,027        | 19.0            | 245          | 2.3             | 8,202       | 79.9            | ..     | ..              | 181          | 1.7             |
| Heifer No. 30 . . . . .  | 7-13-10  | 7,872,000 | 7,766  | 97                                    | 1,328        | 17.1            | 148          | 1.9             | 5,957       | 70.7            | ..     | ..              | 318          | 4.1             |
| Average . . . . .  |          | 7,030,000 | 8,950  | 97.2                                  | 1,433        | 15.6            | 171          | 1.88            | 7,163       | 79.3            | 37     | 0.5             | 253          | 2.8             |
| The following counts were taken after three attacks, Heifer No. 30 having died after the first attack.   |          |           |        |                                       |              |                 |              |                 |             |                 |        |                 |              |                 |
| Daisy . . . . .  | 11-18-10 | 5,056,000 | 19,554 | 88                                    | 4,302        | 22.0            | 1,036        | 5.3             | 14,079      | 72.0            | ..     | ..              | 39           | 0.2             |
| Megs of Hyland . . . . .   | 11-18-10 | 5,872,000 | 43,332 | 95                                    | 2,947        | 6.8             | 1,430        | 3.3             | 37,916      | 87.5            | 43     | 0.1             | 823          | 1.9             |
| Yearling . . . . .   | 11-18-10 | 4,960,000 | 14,444 | 84                                    | 393          | 2.1             | 419          | 2.9             | 13,606      | 94.2            | ..     | ..              | 101          | 0.7             |
| Lady Monkland . . . . .  | 11-18-10 | 5,040,000 | 20,666 | 95                                    | 1,994        | 9.6             | 847          | 4.1             | 15,520      | 75.1            | 62     | 0.3             | 1,384        | 9.6             |
| Average . . . . .  |          | 5,233,000 | 24,499 | 90                                    | 2,384        | 10.2            | 383          | 3.9             | 20,280      | 82.2            | 52     | 0.2             | 586          | 3.1             |
| Daisy . . . . .  | 12- 1-10 | 3,068,000 | 18,444 | 88                                    | 1,420        | 7.7             | 1,107        | 6.0             | 14,811      | 80.3            | ..     | ..              | 1,070        | 5.8             |
| Megs of Hyland . . . . .   | 12- 1-10 | 5,584,000 | 30,888 | 84                                    | 1,820        | 5.9             | 710          | 2.3             | 26,934      | 87.2            | ..     | ..              | 1,390        | 4.5             |
| Yearling . . . . .   | 12- 1-10 | 5,288,000 | 16,332 | 84                                    | 1,633        | 10.0            | 294          | 1.8             | 14,258      | 87.3            | ..     | ..              | 131          | 0.8             |
| Lady Monkland . . . . .  | 12- 1-10 | 6,468,000 | 25,554 | 89                                    | 4,370        | 17.1            | 690          | 2.7             | 20,009      | 78.3            | ..     | ..              | 434          | 1.7             |
| Average . . . . .  |          | 5,312,000 | 22,804 | 86                                    | 2,310        | 10.2            | 700          | 3.2             | 19,003      | 83.2            | ..     | ..              | 756          | 3.2             |
| Daisy . . . . .  | 1-31-11  | 7,040,000 | 32,000 | 85                                    | 4,608        | 14.4            | ..           | ..              | 25,120      | 78.5            | ..     | ..              | 2,272        | 7.1             |
| Megs of Hyland . . . . .   | 1-31-11  | 7,840,000 | 28,888 | 94                                    | 4,333        | 15.0            | 433          | 1.5             | 22,677      | 78.5            | 87     | 0.3             | 1,329        | 4.6             |
| Yearling . . . . .   | 1-31-11  | 7,488,000 | 14,888 | 84                                    | 2,680        | 18.0            | 462          | 3.1             | 11,464      | 77.0            | ..     | ..              | 253          | 1.7             |
| Lady Monkland . . . . .  | 1-31-11  | 6,432,000 | 16,444 | 83                                    | 2,154        | 13.1            | 181          | 1.1             | 13,711      | 77.3            | ..     | ..              | 1,332        | 8.1             |
| Average . . . . .  |          | 7,200,000 | 23,055 | 86.5                                  | 3,444        | 15.1            | 358          | 1.9             | 18,243      | 77.8            | 87     | 0.3             | 1,296        | 5.3             |
| NOTE.—Heifer No. 30 died on the 22d of July. 15 minutes afterward an examination was made with the following results. A sample just before death would have been more reliable and therefore, preferable, but unfortunately we were informed too late. |          |           |        |                                       |              |                 |              |                 |             |                 |        |                 |              |                 |
| Heifer No. 30 . . . . .  | 7-22-10  | 2,192,000 | 31,332 | 32                                    | ..           | 41.4            | ..           | 2.9             | ..          | 53.4            | ..     | ..              | ..           | ..              |
| Daisy . . . . .  | 4-14-11  | 7,440,000 | 31,554 | 90                                    | 4,102        | 13.0            | 726          | 2.3             | 23,445      | 74.3            | 95     | 0.3             | 3,092        | 9.8             |
| Megs of Hyland . . . . .   | 4-14-11  | 5,704,000 | 15,110 | 80                                    | 2,418        | 15.6            | 212          | 1.4             | 11,080      | 74.2            | ..     | ..              | 1,420        | 9.4             |
| Yearling . . . . .   | 4-14-11  | 6,672,000 | 19,554 | 95                                    | 3,050        | 15.6            | 704          | 3.6             | 13,766      | 70.4            | ..     | ..              | 2,034        | 10.4            |
| Lady Monkland . . . . .  | 4-14-11  | 6,760,000 | 20,666 | 89                                    | 2,144        | 10.4            | 434          | 2.1             | 15,706      | 76.0            | 41     | 0.2             | 2,315        | 11.2            |
| Average . . . . .  |          | 6,644,000 | 21,721 | 88.5                                  | 2,930        | 14.0            | 519          | 2.3             | 15,994      | 73.4            | 68     | 0.25            | 2,215        | 10.2            |

second examination was made on the 1st of December, the third on the 31st of January, and the last on the 14th of April.

We note that there was a decrease in reds still but that the number was gradually approaching the normal. The percentage of hemoglobin also decreased, while the number of leukocytes increased beyond the normal and was continuing to increase.

TABLE 12.  
OBSERVATIONS OF FIVE HEIFERS.  
General Results.

|                                | BEFORE<br>TREATMENT | AFTER TREATMENT  |                 |                |                 |
|--------------------------------|---------------------|------------------|-----------------|----------------|-----------------|
|                                |                     | Date<br>11-18-10 | Date<br>12-1-10 | Date<br>1-3-11 | Date<br>4-14-11 |
| Reds. ....                     | 7,030,000           | 5,233,000        | 5,312,000       | 7,200,000      | 6,644,000       |
| Whites. ....                   | 8,950               | 24,444           | 22,804          | 23,005         | 21,721          |
| Percentage of Hemoglobin. .... | 97                  | 90               | 80              | 86.5           | 88.5            |

Differential Count of Whites.

|                    | Number | Per<br>cent | Number | Per<br>cent | Number | Per<br>cent | Number | Per<br>cent | Number | Per<br>cent |
|--------------------|--------|-------------|--------|-------------|--------|-------------|--------|-------------|--------|-------------|
| Polynuclears. .... | 1,433  | 15.6        | 2,384  | 10.2        | 2,310  | 10.2        | 3,444  | 15.0        | 2,930  | 14.0        |
| Mononuclears. .... | 171    | 1.88        | 383    | 3.0         | 700    | 3.2         | 858    | 1.9         | 519    | 2.3         |
| Lymphocytes. ....  | 7,163  | 79.3        | 20,280 | 82.2        | 19,003 | 83.2        | 18,243 | 77.8        | 15,994 | 73.4        |
| Mast. ....         | 37     | .5          | 52     | .2          | .....  | .....       | 87     | .3          | 68     | .2          |
| Eosinophiles. .... | 253    | 2.8         | 586    | 3.1         | 756    | 3.2         | 1,296  | 5.3         | 2,215  | 10.2        |

A glance at the table will reveal an increase in the percentage of lymphocytes, eosinophiles, and mononuclears and a decrease in the percentage of polynuclears and mast cells.

#### CONCLUSIONS.

Our original observations on 15 animals in the dairy herd gave us results which, when compared with those of other observers, showed some marked differences. The most apparent differences are noted as follows: (1) The number of whites is appreciably larger. (2) The number and percentage of polynuclears are smaller. (3) The number and percentage of lymphocytes are larger. Other differences, though not so apparent and possibly of very little value, are noted as follows: (1) The number and percentage of mast cells have decreased, while the number and percentage of eosinophiles and mononuclears have increased.

These same differences were observed when the above 15 animals were further examined at various times and over a period of two years. When the results of the original 15 animals were compared with the results of a set of 15 animals from the general herd, the same differences were also noted. Furthermore, we observed similar differences when we examined 41 cows in the general herd.

To account for these differences was our next object, for we did not consider that we had established a new normal. The idea that tick fever might have such an effect on the blood of the animal that had passed through one or more attacks persistently suggested itself; so when five Ayrshire heifers were imported from Pennsylvania, observations were immediately made to establish a normal. After these observations the animals were put through a system of immunization to tick fever. A month after they had passed through three attacks and were considered in good condition, the blood was examined at four different times. These results were found to be similar to our other results. The number of cases (four) is small, and though too small to draw definite conclusions from, we believe that we have sufficient indication to justify our position and hope on further observation to establish this fact without a doubt.

One animal died and observations 15 minutes after death showed an increase of whites. We have found this to be true in three other cases. It is hoped that time and material will be available for a more thorough study of the leukocytes in the last stages of the disease.